Evolving and Certifiable Autopilot for Unmanned Aerial Systems, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

The project consist of the development of a new intelligent flight control system with learning capabilities and a high degree of assurance, that can be certified by the FAA

Machine learning and artificial intelligent research has led to many tangible results and recent developments in cognitive control and decision making. Although automatic flight controllers are widely used and they have become common in recent years, they often lack intelligence, adaptability, and high performance. Reliability of UASs in unforeseen conditions is a direct function of their intelligence and adaptability.

The proposed project aims to take advantage of high-performance computing platforms and the state-of-the art machine learning and verification algorithms to develop a new intelligent, adaptable, and certifiable flight control system with learning capabilities. The autopilot system will be able to learn from each flight experience and develop intuition to adapt to a high level of uncertainties. To provide a high degree of assurance and to make the learning autopilot system safe and certifiable, a secondary and conventional autopilot system will be integrated based on the run-time assurance architecture. A monitor will be developed to continuously check aircraft states and envelope protection limits, and handover aircraft control to the conventional autopilot system if needed. Provable guarantees of the monitor and the controllers will be provided using formal analysis. The propose a hybrid flight control system which has adaptability and intelligence of skilled pilots and at the same is cable of performing complex analysis and decision making algorithms in real-time. We aim to build and train an artificial neural network model that can mimic the performance of the classical robust optimal controllers, extend the robustness, adaptability, and curiosity of the artificial neural network controller and integrate a Real-Time Assurance (RTA) system.

Anticipated Benefits

The autopilots could be used on many of NASA's currently flying UAS's and newly developed systems.

The autopilot can be used on any commercially and military available UAS system.
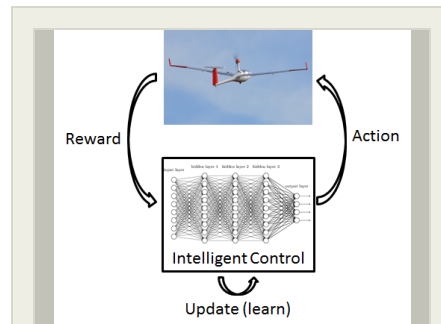
Evolving and Certifiable Autopilot for Unmanned Aerial Systems, Phase I
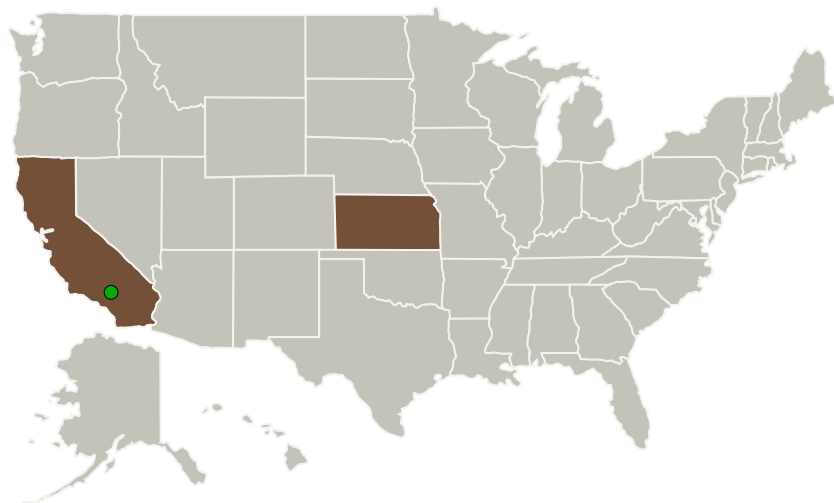
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Completed Technology Project (2018 - 2019)

Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
Design Analysis & Research Corporation	Lead Organization	Industry	Lawrence, Kansas
🟢 Armstrong Flight Research Center(AFRC)	Supporting Organization	NASA Center	Edwards, California

Primary U.S. Work Locations	
California	Kansas

Project Transitions

▶ **July 2018:** Project Start

✓ **February 2019:** Closed out

Closeout Documentation:
- Final Summary Chart(*https://techport.nasa.gov/file/141043*)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Design Analysis & Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:
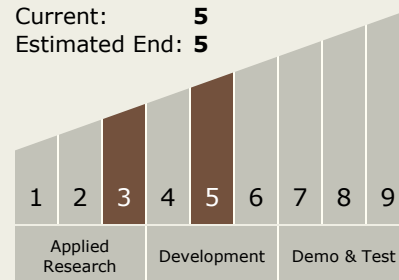
Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Willem Anemaat

Technology Maturity (TRL)

Start: **3**
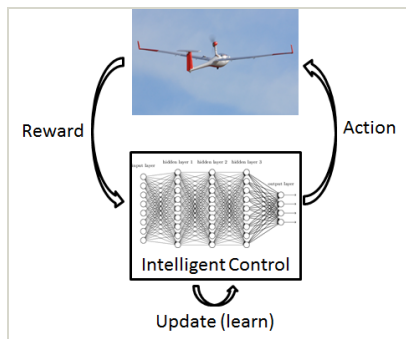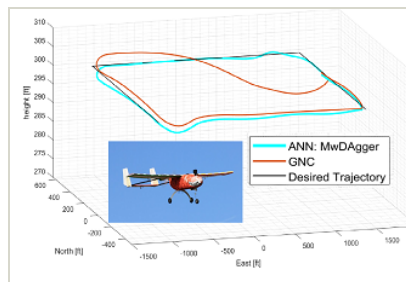Current: **5**
Estimated End: **5**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Images

Briefing Chart Image
Evolving and Certifiable Autopilot for Unmanned Aerial Systems, Phase I
(https://techport.nasa.gov/image/130959)

Final Summary Chart Image
Evolving and Certifiable Autopilot for Unmanned Aerial Systems, Phase I
(https://techport.nasa.gov/image/131415)

Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.3 Aero Propulsion
    └ TX01.3.1 Integrated Systems and Ancillary Technologies

Target Destination
Earth